Discoverer II
Space Based Radar Concept

DARPATech 2000

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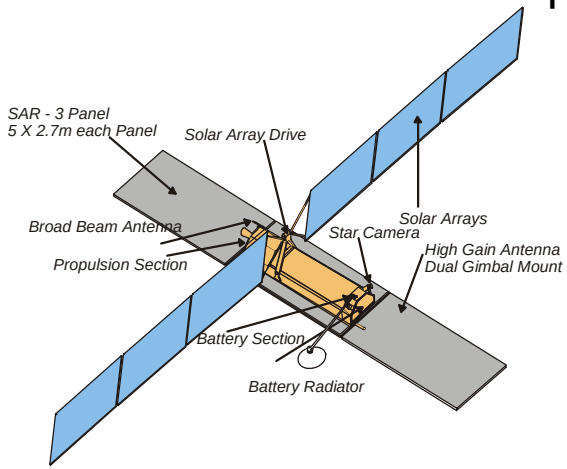
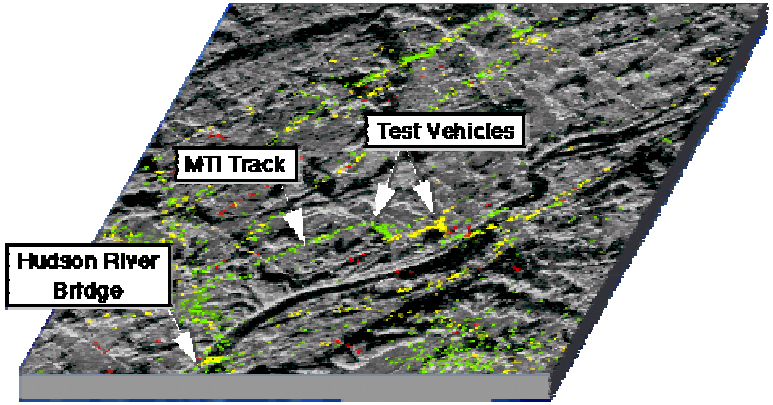
Outline

- **The Discoverer II Concept**
- **New Capabilities**
- **Active Electronic Scanned Antenna**
- **Space Based Information Processing**
- **Mission Utility**

Discoverer II Space Radar Objectives

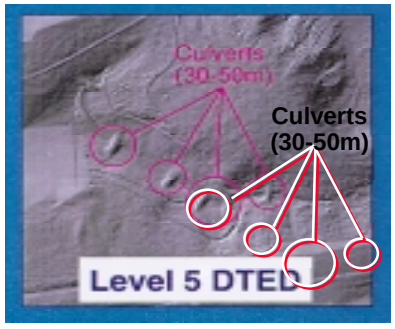
Affordable AESA Spacecraft





MTI Overlaid on SAR Image

- **Feasibility of GMTI from space**
- **Tracking of ground vehicles**
- **Dynamically tasked imaging of ground targets**
- **Collection of terrain elevation data**
- **Show affordability MTI from space**



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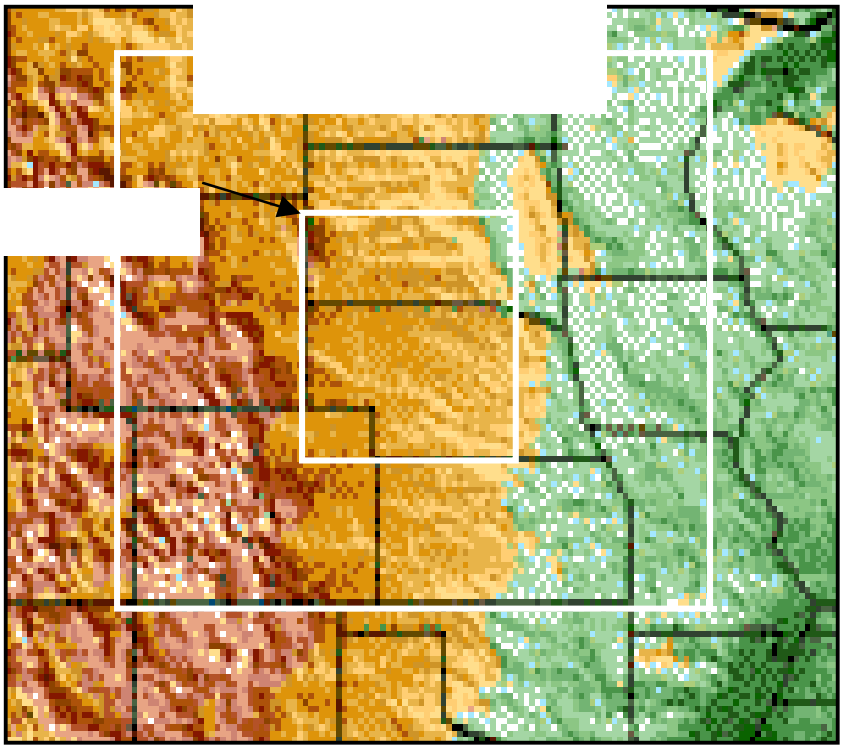
Why Moving Target Indication (MTI)?

- Detect, characterize, and track movers (e.g. critical mobile targets)
- Wide area cueing filter for other modes /ISR assets

Desired Attributes:

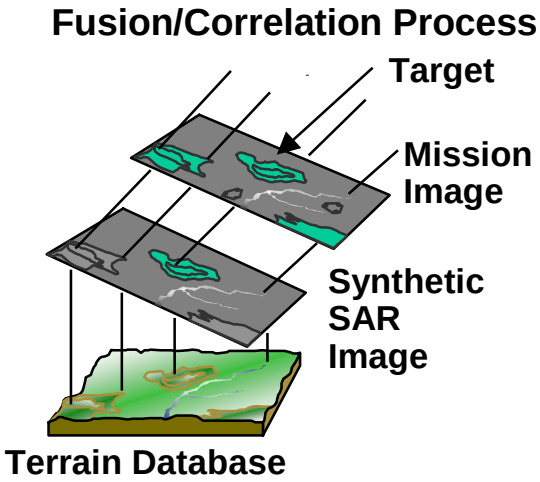
- Cover multiple theaters of interest
- "Birth-to-death" tracking
- High range resolution (HRR) for target classification & tracking

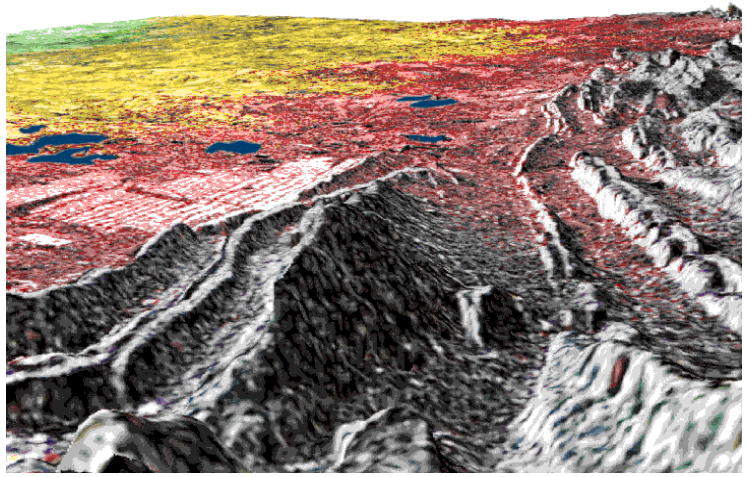
24-Satellite Area Coverage per Day



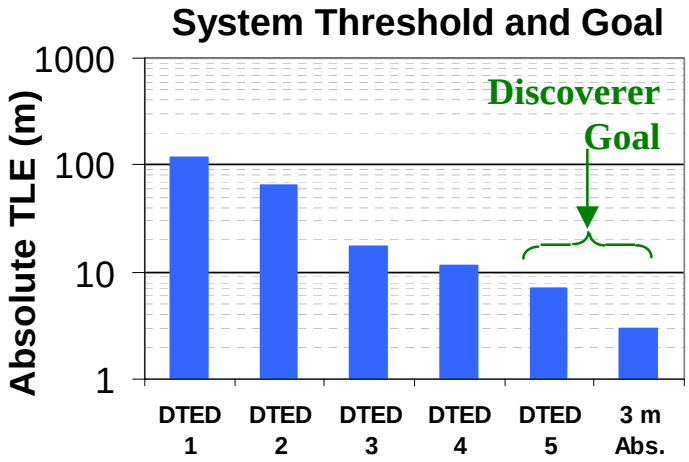
Why Digital Terrain Elevation Data (DTED)?

- **Provide common grid for sensor data fusion**
  - Day/night, all weather
- **Generate accurate feature location data for targeting and other warfighter applications**





DTED



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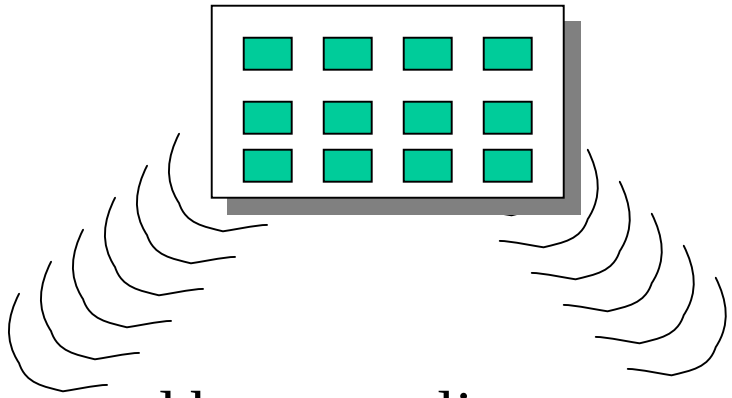
Affordable Space Based Radar

Active Electronically Scanned Antenna is a key enabler

- Change look direction without mechanical slew
  - Simplified satellite bus

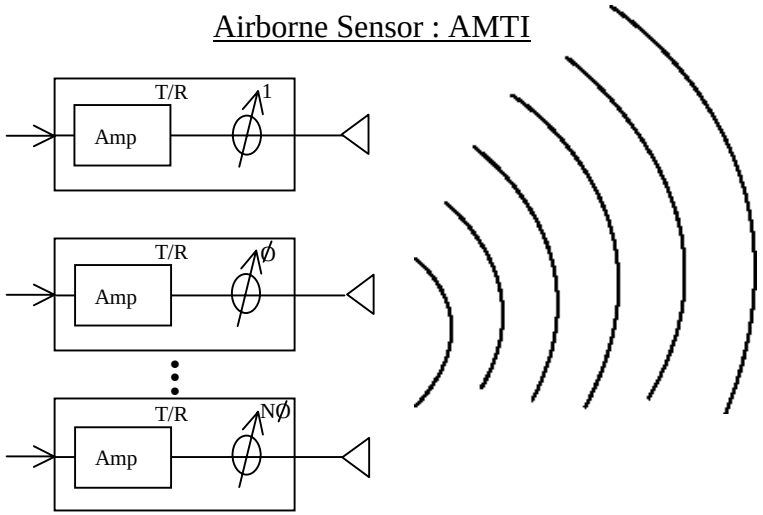


Affordable AESA requires innovation

- Array thinning
  Reduce # modules while retaining scan and beam quality
- Manufacturing
  Heavy automation & streamlined testing
- Adaptive digital radar and signal processing technology
  Relaxed radar tolerances

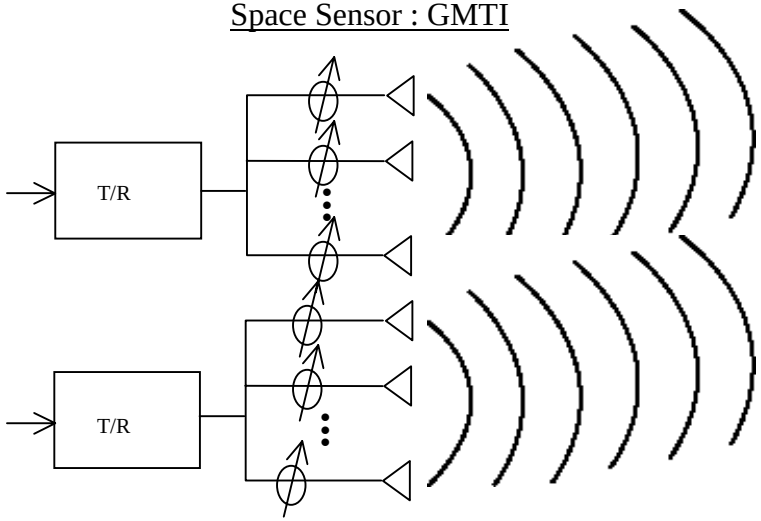
ESA: Space vs. Airborne

Airborne Sensor : AMTI



- **Technical Challenge: Compactness**
- **Solution: High power, small aperture**
  - 1 element/(T/R)

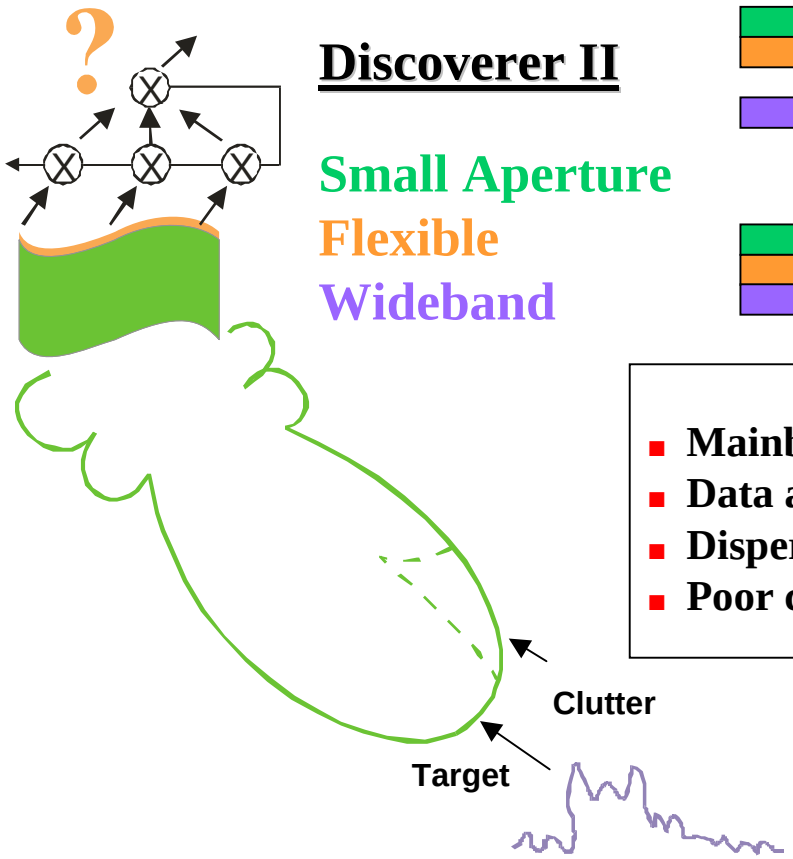
Space Sensor : GMTI



- **Technical Challenge: Power drain, long-range, large field of view**
- **Solution:**
  - Thinned arrays, large aperture, electronic agility

Affordable space AESA leads to large, low-power systems: new challenges

Revolutionary Affordability for Global Surveillance: Satellite Form Factor



Discoverer II

Small Aperture
Flexible
Wideband

- Light, low-cost, multiple satellite/launch
- Increased range resolution enables mainbeam rejection
- Clutter rejection requires Space-Time Adaptive Processing

Challenges	Key Enablers
▪ Mainbeam interference	▪ Sub-band architecture
▪ Data adaptive calibration	▪ Teraflop-class processing
▪ Dispersion mitigation	▪ Wideband communications
▪ Poor cross-range resolution	▪ HRR MHT tracker

Emerging information technologies enable affordable constellation

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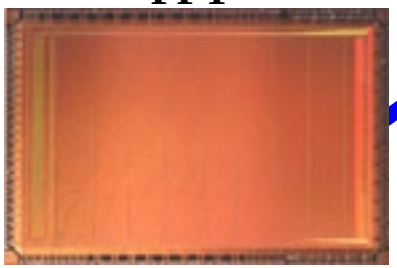
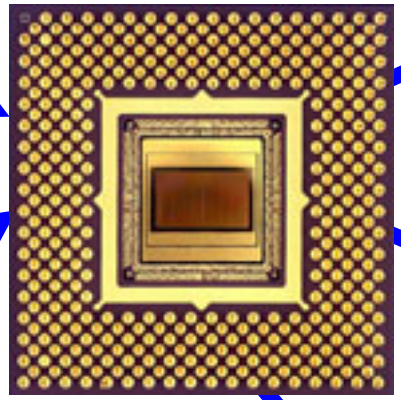
Wideband Digital Processing Enables Relaxed Antenna Specifications

Polyphase Filter

FFT

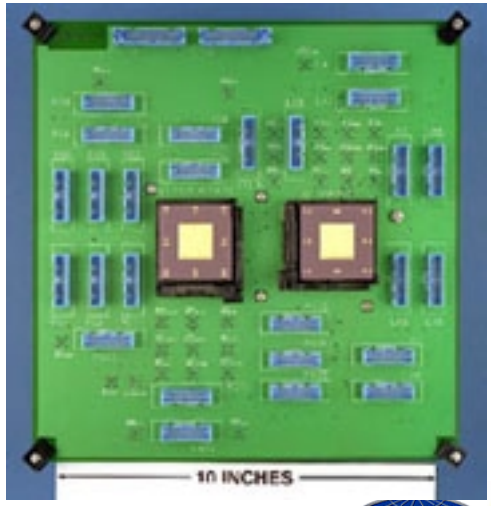


PGA Packaging



Polyphase Filter Test Board

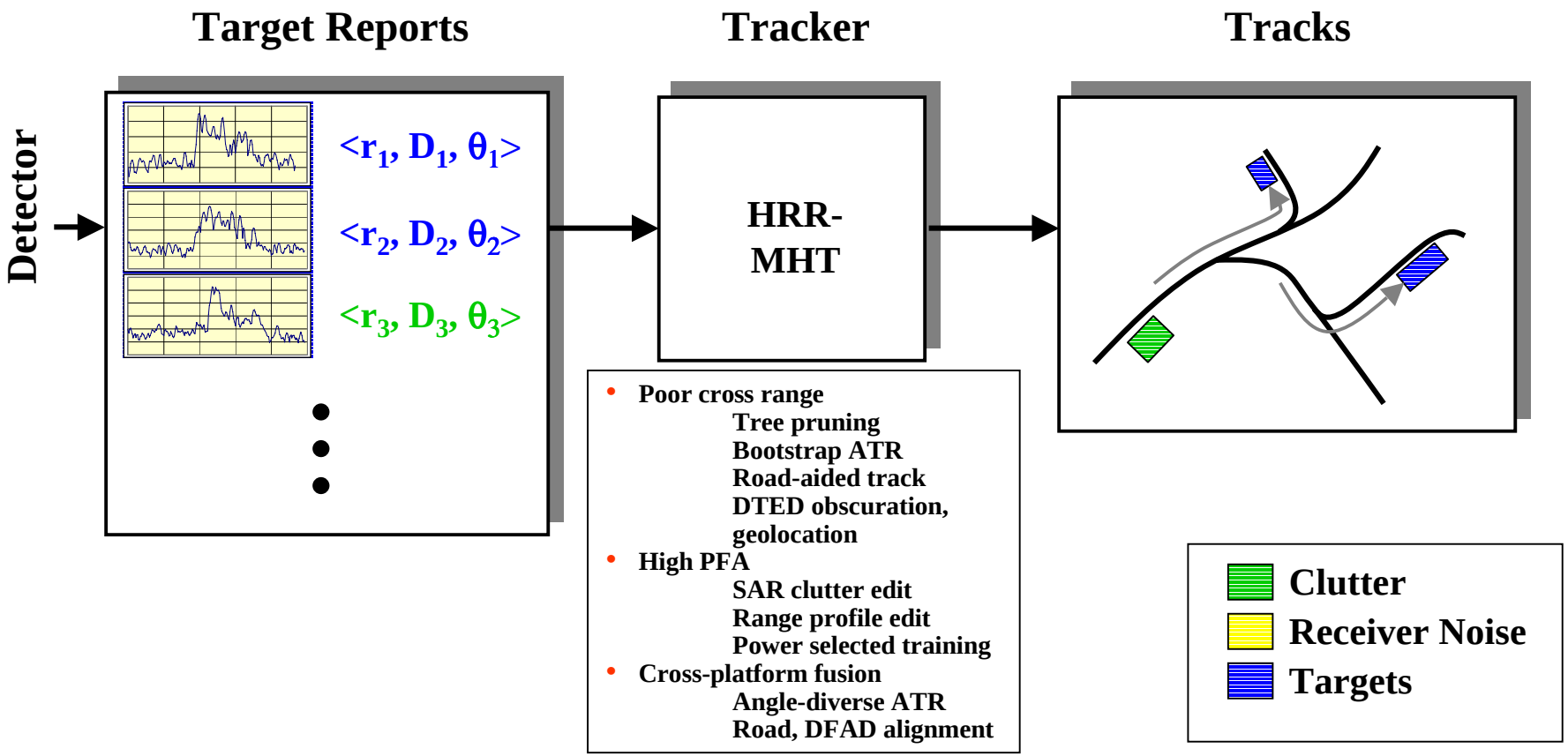
FFT Test Board



Polyphase Channelizer Demonstration Board

- **Fabricated 0.25-µm CMOS Process**
- **128-channel, 12-tap Polyphase Filter**
  - 6 million transistors, 60K processors
  - 32 GOPS
- **128-point Complex FFT Processor**
  - 3.5 million transistors, 35K processors
  - 23 GOPS

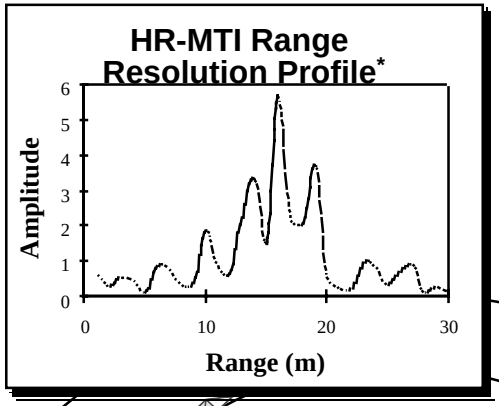
Discoverer II Signal Processing Flow: Tracker

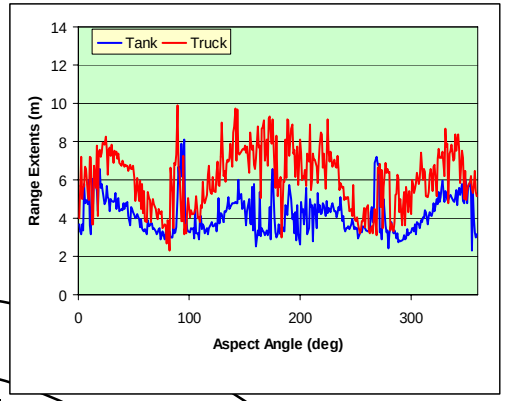


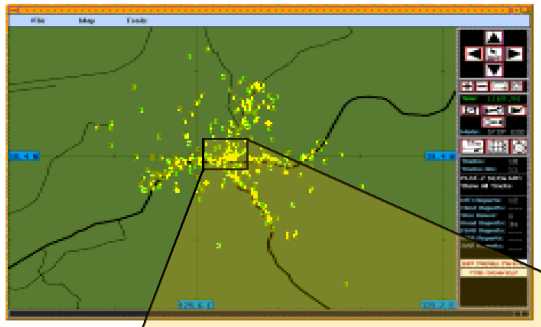
Tracker compensates for platform stand-off/diversity

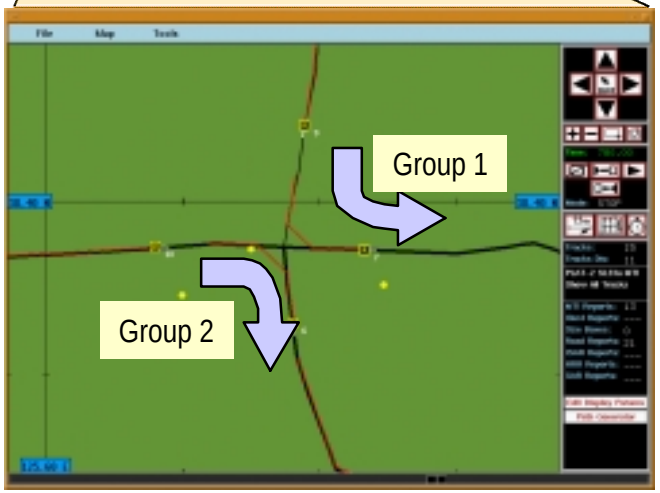
Feature-aided Tracking

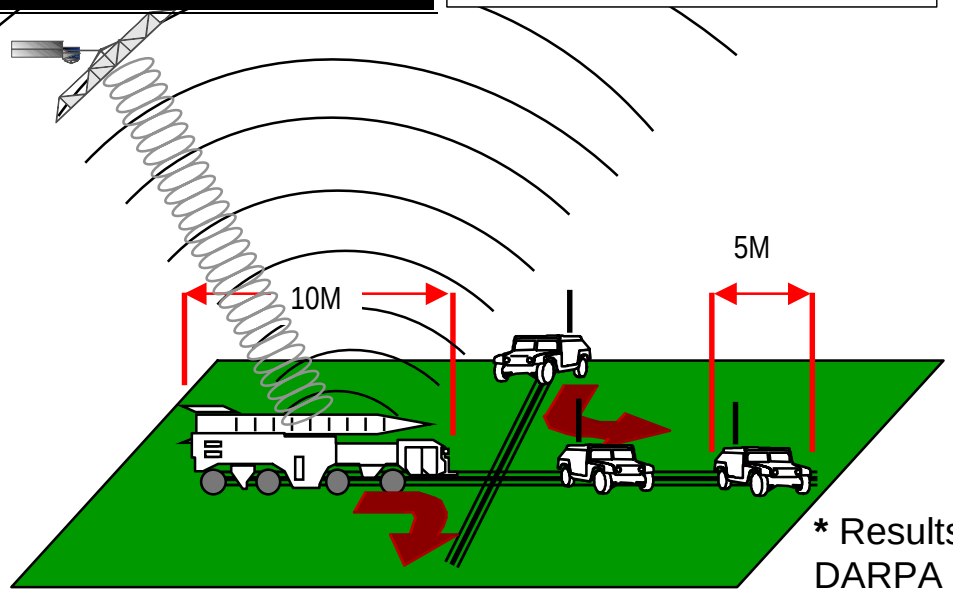
- **High range resolution allows target deconfliction**











* Results derived from MSTARS collections, DARPA MTE Program, 11/97

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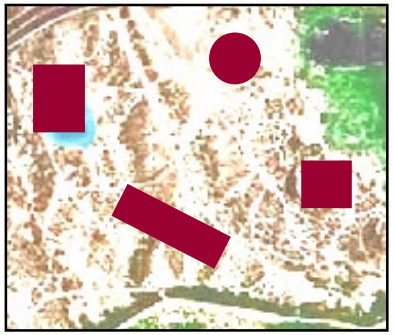
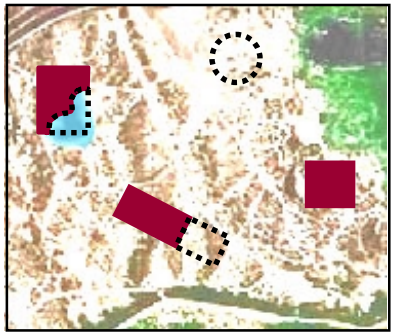
Prospective Strategic Relocatable Targets/Critical Mobile Targets Applications

1 IDENTIFY SCUD OPERATIONAL AREAS (IPB)



2 DE-LIMIT AREAS OF UNCERTAINTY (DTED)

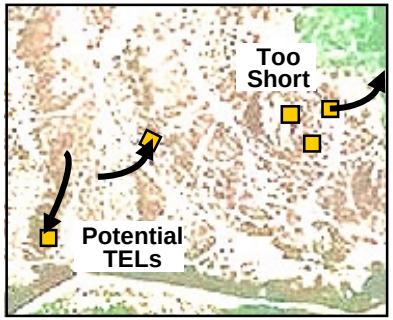


3 IDENTIFY ALL PROSPECTIVE TARGETS. FILTER OUT NON-VEHICLES (SAR & MTI)

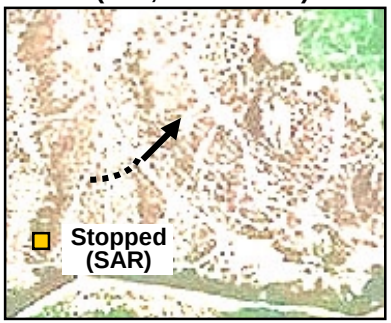
4 EXPLOIT SBIRS CUE (IF AVAILABLE)

5 IDENTIFY TRACK MOVERS (MTI)

6 CLASSIFY MOVERS (HRR-MTI WITH SAR)



7 IDENTIFY HIDE POINTS CONFIRM TARGETS CUE & COMMIT SHOOTERS (MTI, THEN SAR)



8 BDA (SAR & MTI)